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EP 127958 IPC G01N 27/30, 1984
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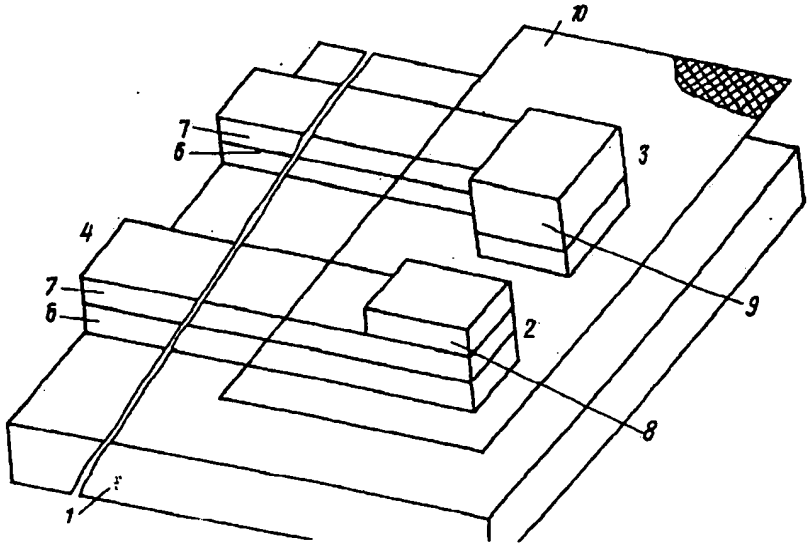
(54) ELECTROCHEMICAL SENSOR TO DETERMINE CONTENT OF GLUCOSE

(57) Abstract: The invention relates to the technique for studding and analyzing materials by determining electrochemical parameters and can be used to determine glucose concentration in biological solutions, for instance, blood. A technical result achievable by using the claimed invention as compared to the known technical solution is an increased accuracy due to the decrease in technological characteristic variations of the sensors, an improved sensitivity, and a simplified sensor manufacture technology. The sensor includes a substrate 1 of an insulating material, a counter electrode 2, a multiplayer detecting electrode 3, corresponding current-conducting lead-outs 4, 5, graphite layers 6 of the counter and detecting electrodes and of the corresponding current-conducting lead-outs, silver layers 7 of the counter electrode and of the current-conducting lead-outs of the counter and detecting electrodes, an AgCl layer 8 of the counter electrode, a sensing layer 9 of the detecting electrode, and a polymer mesh 10. The technical result is achieved by means of the interaction more effective than the surface interaction between the enzyme and the mediator in the homogeneous sensing layer of the detecting electrode. 1 drw.



The invention relates to the technique for studding and analyzing materials by determining electrochemical parameters and can be used to determine glucose concentration in biological solutions, for instance, blood.

An electrochemical sensor [1] for determining glucose concentration is known from the prior art, said sensor consisting of a platinum anode having a separation membrane applied thereon and provided with an enzyme membrane, a diffusion membrane, and a microporous membrane.

A drawback of this sensor is a relatively weak output current of from 14 to 136 nA in the interesting glucose concentration range of from 2 to 20 mMole/l as well as a low operating speed (a time needed for establishing the steady-state electrode current of 1-1.5 min).

An electrochemical sensor for determining glucose concentration [2] is the closest one to the claimed sensor.

The known electrochemical sensor for determining glucose concentration comprises a substrate of an isolating material with a counter electrode and a multiplayer detecting electrode both being arranged on the substrate, and the electrodes being covered with a polymer mesh, wherein a lower layer of the detecting electrode is made of graphite and other layers thereof are made of a mediator and an enzyme, respectively.

A drawback of this known electrochemical sensor is a low accuracy as a consequence of high technological characteristic variation of the sensors due to the complicated, poorly reproduced, expensive and low-productive process for immobilizing glucose oxidase onto the mediator layer and a low sensitivity as a consequence of the surface interaction between the enzyme and mediator layers.

Thus, technical results achievable by using the claimed invention as compared to the known technical solution are an increased accuracy due to the decrease in technological characteristic variations of the sensors, an improved sensitivity, and a simplified sensor manufacture technology.

The above technical results are achieved by an electrochemical sensor for determining glucose concentration, said sensor comprising a substrate of an isolating material with a counter electrode and a multiplayer detecting electrode a lower layer of which being made of graphite, both electrodes being arranged on the substrate and having a polymer mesh placed thereon, wherein the detecting electrode comprises two layers, an upper sensing layer being made of a homogeneous paste containing a graphite powder, a solution of ferrocene in toluene, a solution of glucose oxidase in a mixture of dimethylsulfoxide (DMSO) and water taken in a ratio of 1:4, and an organic binder.

The drawing shows a structure of the claimed electrochemical sensor for determining glucose concentration.

The sensor includes a substrate 1 made of an insulating material, a counter electrode 2, a multiplayer detecting electrode 3, corresponding current-conducting lead-outs 4, 5, graphite layers 6 of the counter and detecting electrodes 2, 3 and of the corresponding current-conducting lead-outs 4, 5, silver layers 7 of the counter electrode 2 and of the current-conducting lead-outs 4, 5 of the counter and detecting electrodes 2, 3, an AgCl layer 8 of the counter electrode 2, a sensing layer 9 of the detecting electrode 3, and a polymer mesh 10.

In the manufacture of the claimed electrochemical sensor for determining glucose concentration, the multiplayer counter and detecting electrodes are applied onto the substrate of the insulating material by the screen printing technique. During this process, the graphite layers for the counter and detecting electrodes and for the corresponding current-conducting lead-outs are simultaneously applied onto the substrate, then the silver layer is simultaneously applied onto the graphite layers of the counter electrode together with the corresponding current-conducting lead-out and onto the graphite layer of the corresponding current-conducting lead-out of the detecting electrode,

thereafter the AgCl layer is applied onto the silver layer of the counter electrode, thereafter a layer of a homogeneous enzyme-mediator paste is applied onto the graphite layer of the detecting electrode, followed by drying at a temperature of 40°C for one hour, and then the electrodes are covered with the polymer mesh. The homogeneous enzyme-mediator paste is prepared by mixing a graphite powder with a solution of ferrocene in toluene followed by grinding till the mediator-modified graphite powder becomes completely dry, then a solution of glucose oxidase in a mixture of H_2O:DMSO of a 1:4 volume ratio is added followed by grinding for complete drying and by finish drying for 4 hours at a temperature of 40°C, and then the thus produced powder is mixed with an equivalent amount of a binder in a solvent to obtain the homogeneous paste.

The device is operated as follows.

A droplet of a glucose-containing solution, e.g. of blood, is applied on the counter and detecting electrodes of the sensor, ends of the current-conducting lead-outs of said electrodes being placed into a contact device of a analytical instrument. The principle of operation is based on the direct registration of a reaction for oxidizing of glucose by glucose oxidase. The electrodes released during the reaction generate a current flowing in a measuring circuit of the analytical instrument. When a predetermined time period after starting the reaction is expired, a reading for the instrument data should be performed to obtain a result which is proportional to the glucose concentration. The claimed sensor is a disposable device for single use.

The technical results are achieved by means of the interaction more effective than the surface interaction between the enzyme and the mediator in the homogeneous sensing layer of the detecting electrode.

CLAIM

An electrochemical sensor for determining a content of glucose, comprising a substrate of an isolating material with a counter electrode and a multiplayer detecting electrode a lower layer of which being made of graphite, both electrodes being arranged on the substrate and having a polymer mesh placed thereon, characterized in that the detecting electrode comprises two layers, wherein an upper sensing layer is made of a homogeneous paste containing a graphite powder, a solution of ferrocene in toluene, a solution of glucose oxidase in a mixture of dimethylsulfoxide and water taken in a ratio of 1:4, and an organic binder.